Intel Server Technology Update

Dr. Dileep Bhandarkar
Senior Server Platform Architect
Digital Enterprise Group

May 17, 2006

Agenda

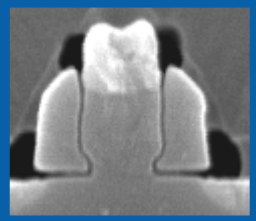
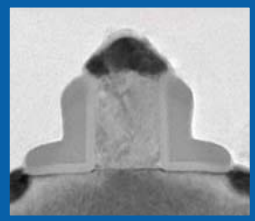
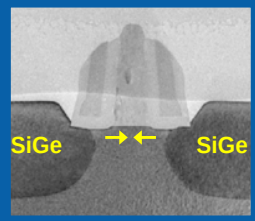
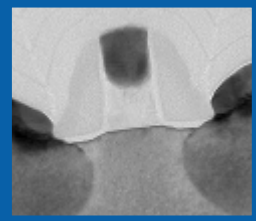
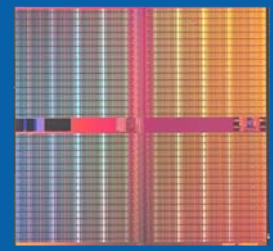
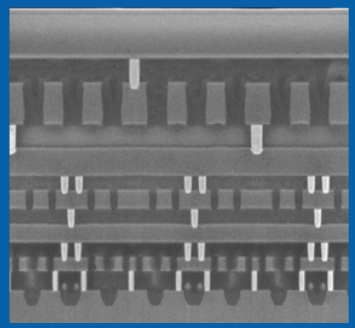
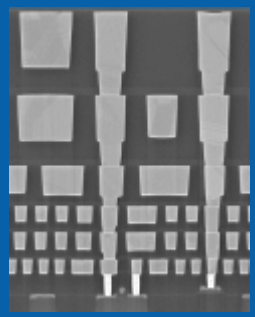
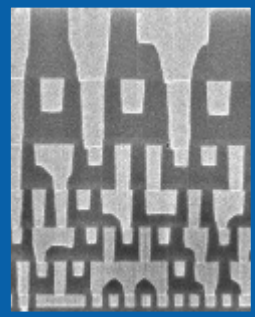
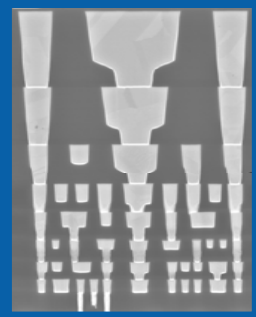
Process Technology & Manufacturing

Multicore Processor Technology

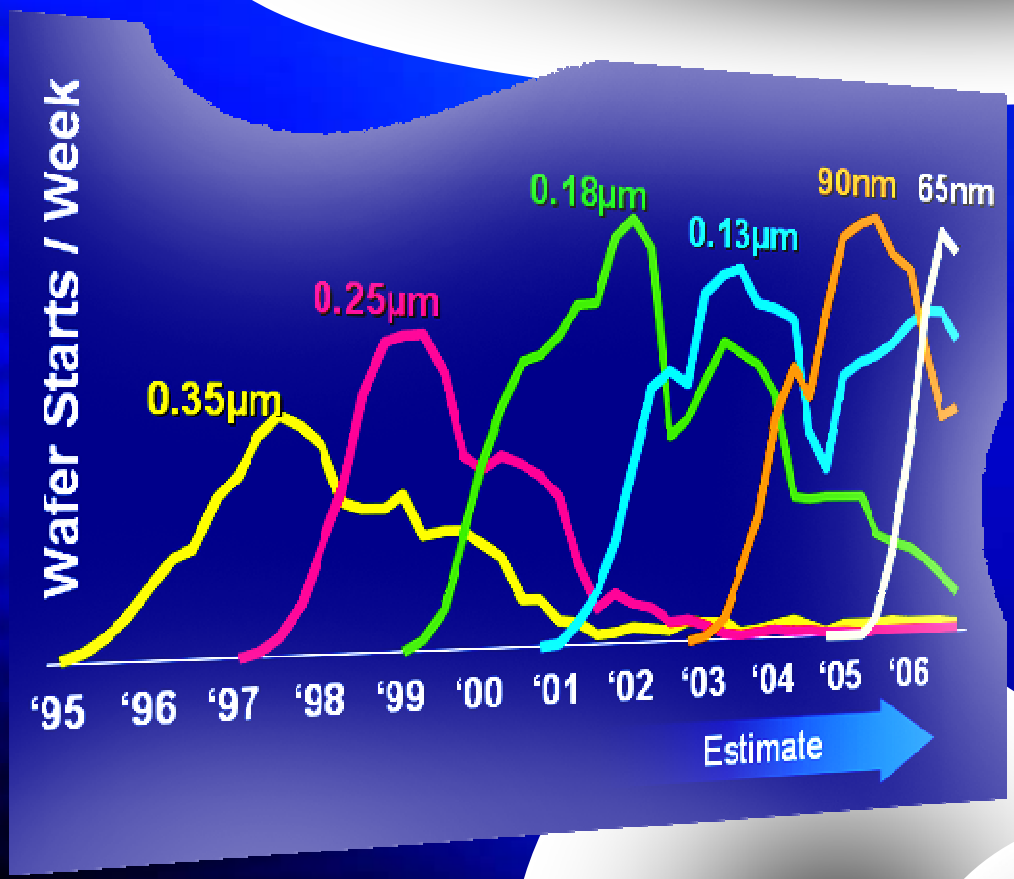
New Intel® Core™ Microarchitecture

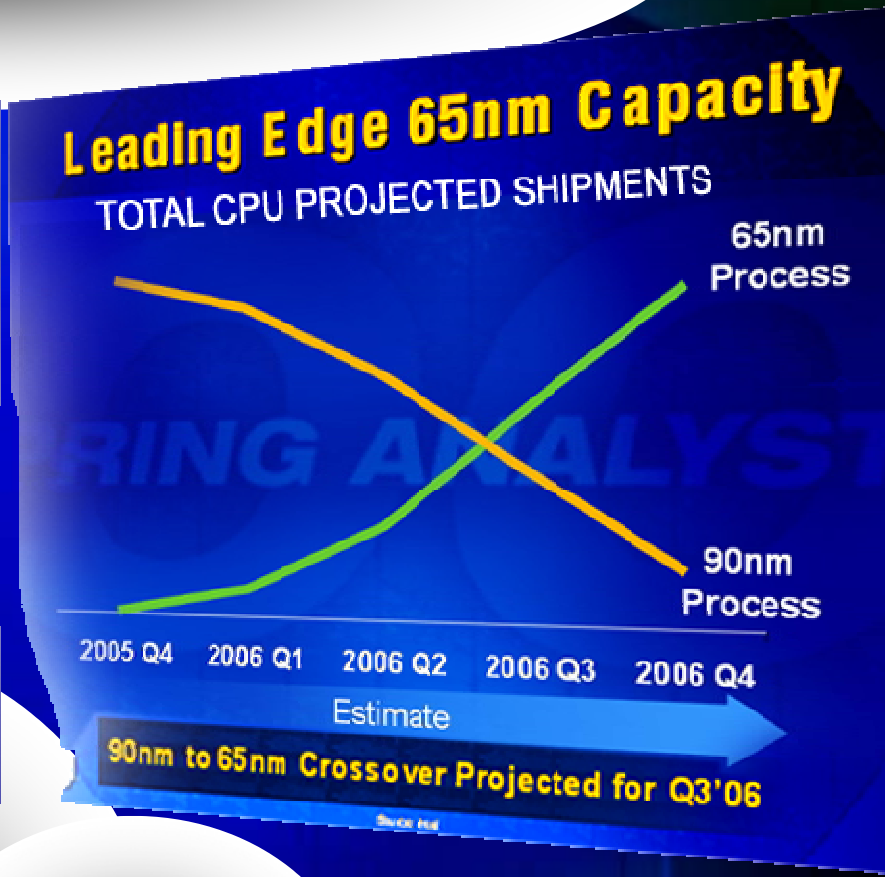
Server Architecture Enhancements

Intel Drives 2-Year Cycle

	180nm	130nm	90nm	65nm	45nm
Wafer Size (mm):	200	200/300	300	300	300
1st Production:	1999	2001	2003	2005	2007
Transistors:					
Interconnects:					
	100nm L_G $CoSi_2$	**70nm L_G $CoSi_2$**	**50nm L_G NiSi Strain Si**	**35nm L_G NiSi Strain Si**	**Details Coming!**
	6 Al SiOF	**6 Cu SiOF**	**7 Cu Low-k**	**8 Cu Low-k**	

Technology & Manufacturing Pipeline






D1D Oregon

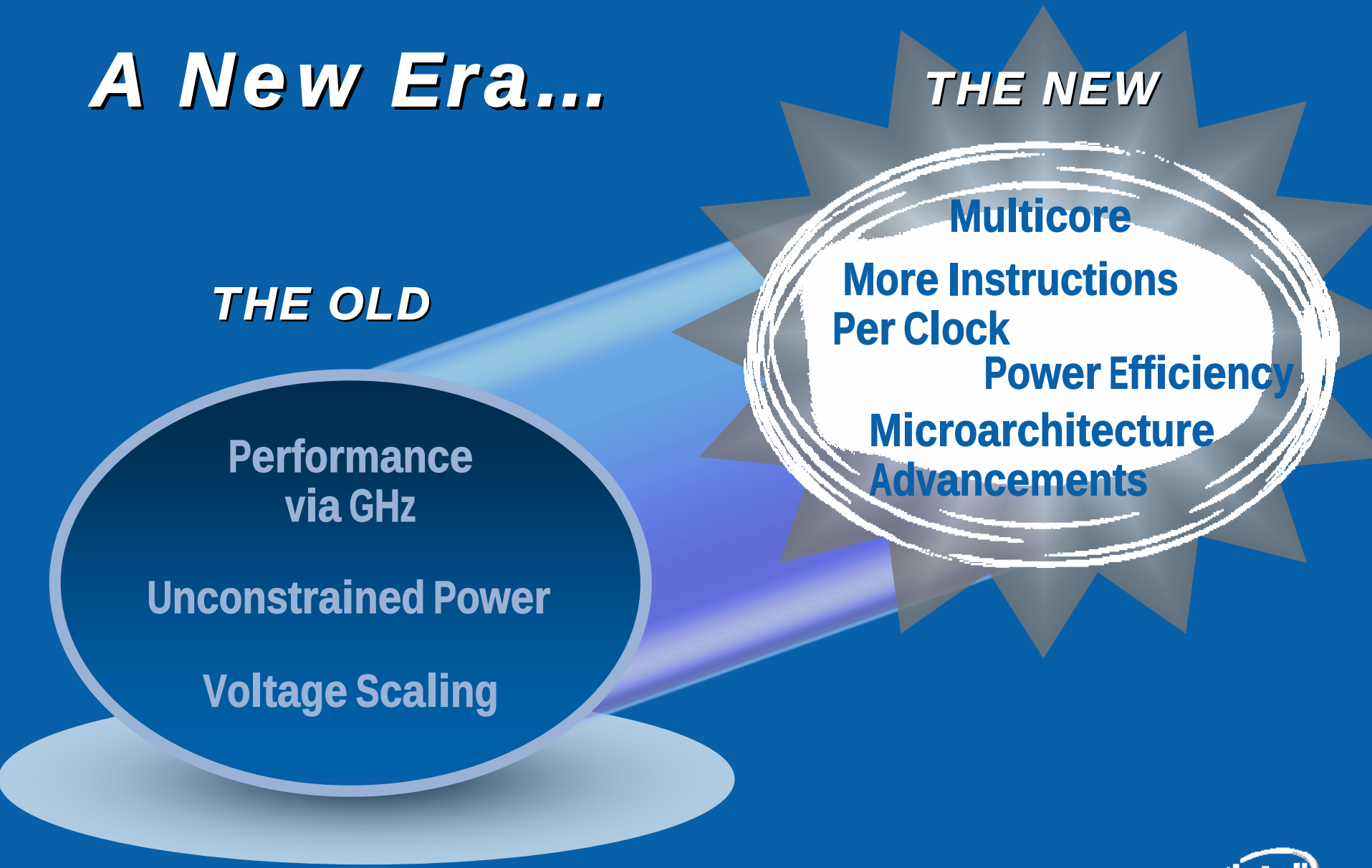

D1C Oregon


12C Arizona

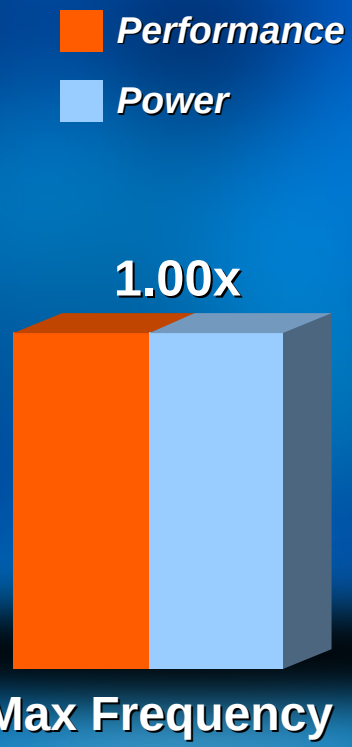

24E Ireland

45nm
32 Arizona
28 Israel

A New Era...

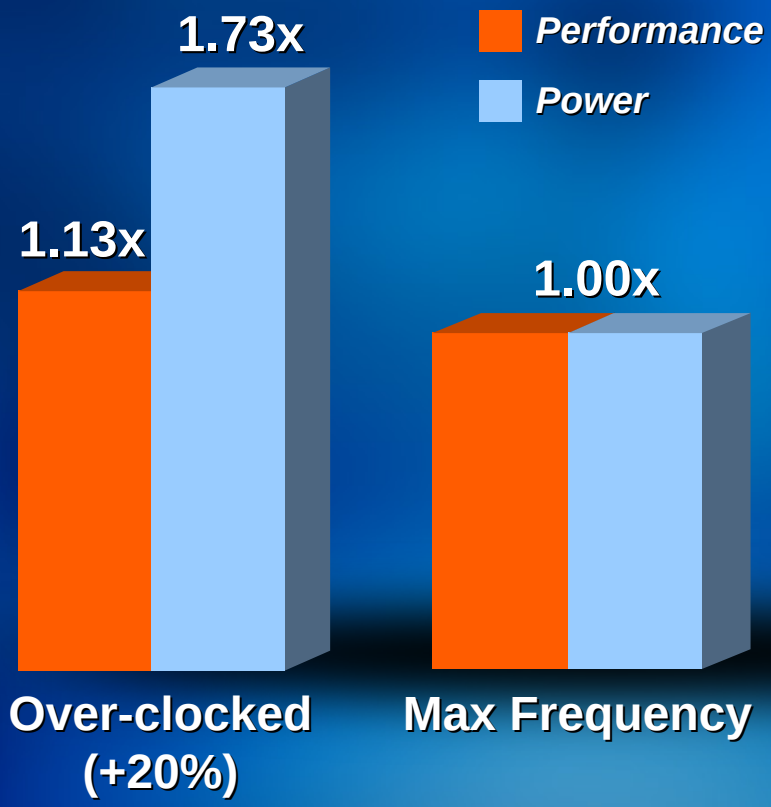

THE OLD
Performance via GHz
Unconstrained Power
Voltage Scaling
THE NEW
Multicore
More Instructions Per Clock
Power Efficiency
Microarchitecture Advancements

Why Multi-Core?



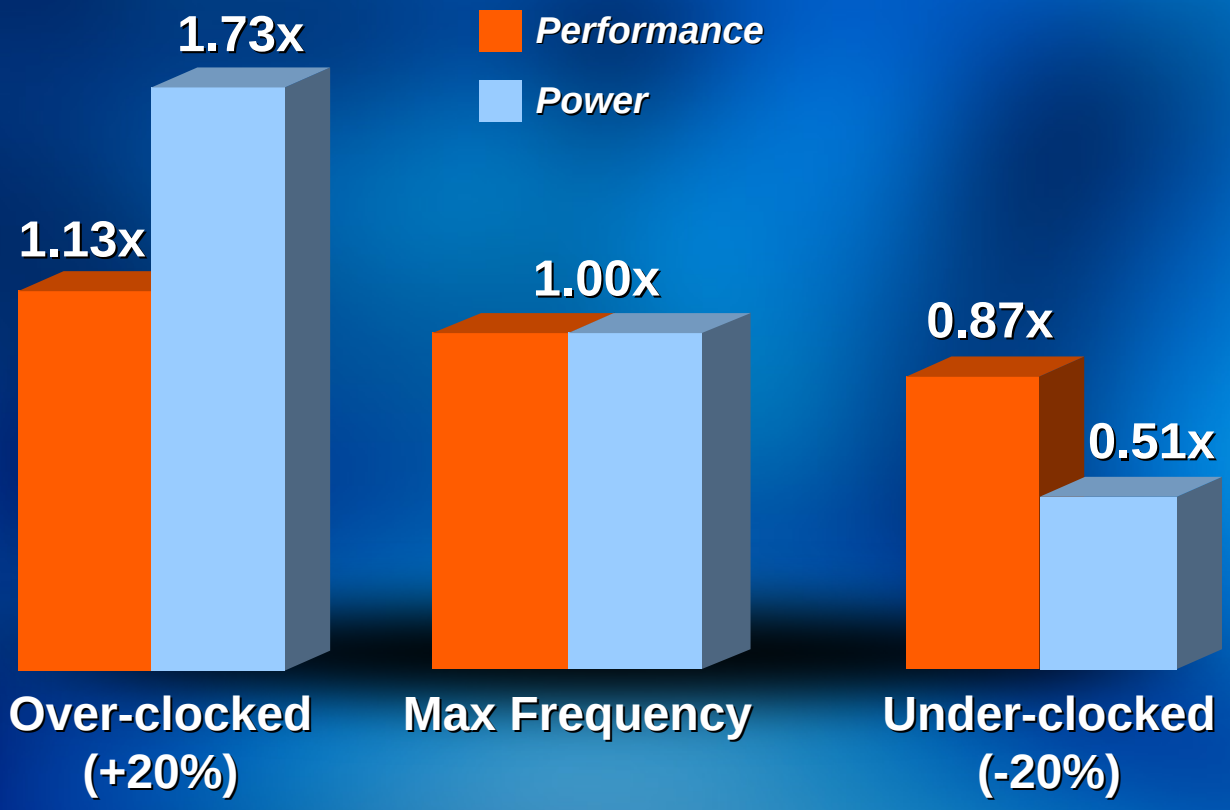
Relative single-core frequency & Vcc

Over-Clocking Example



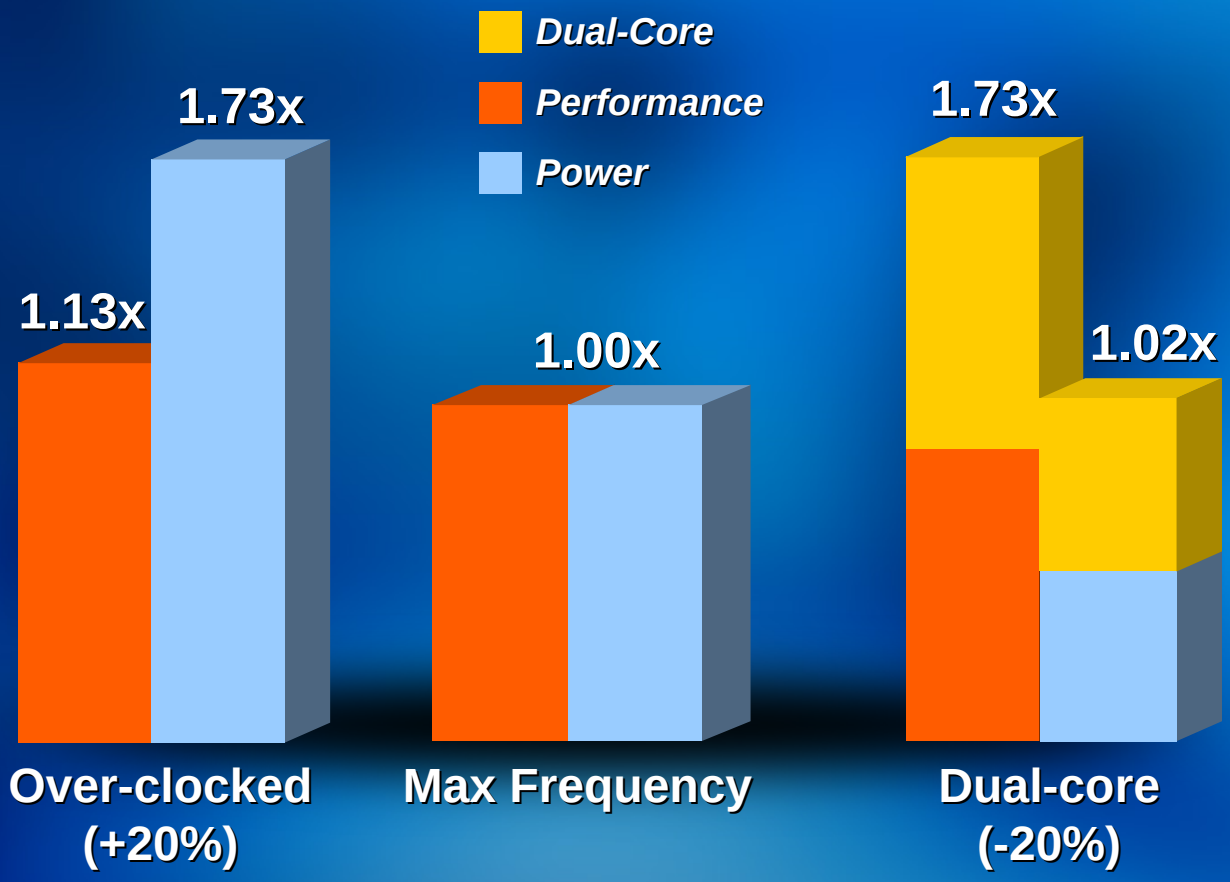
Relative single-core frequency & Vcc

Under-Clocking Example



Relative single-core frequency & Vcc

Multicore Delivers Energy-Efficient Performance



Relative single-core frequency & Vcc

Ramping Multicore Everywhere

	2005	2006*	2007*
Desktop Mainstream/Performance	Shipping	>75%	>90%
Mobile Mainstream/Performance	Shipping	>90%	>90%
Server	Shipping	>85%	~100%


Desktop Client


Mobile Client

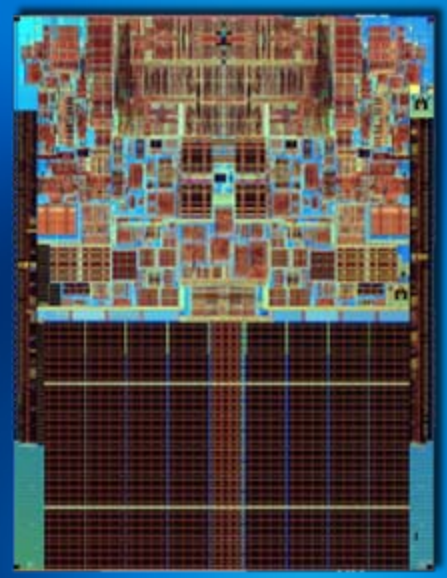

Server & Workstation

* Data is projected run rate exiting the year. Source: Intel

Expect to ship >60 million multicore processors in 2006

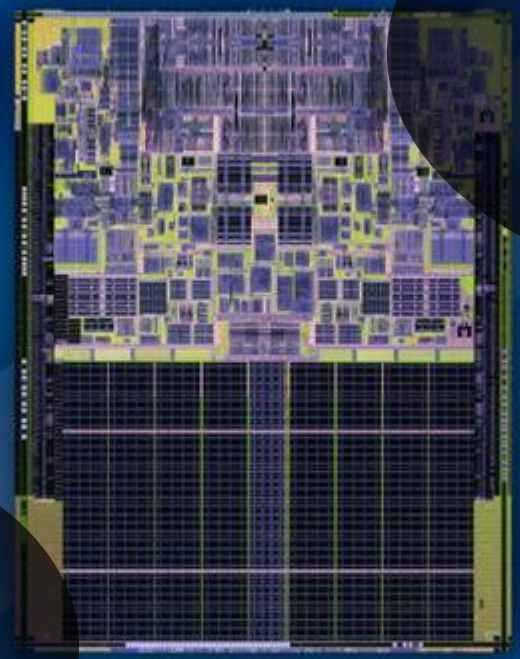
Intel® Core™ Microarchitecture

- **Design Goals:**



- **World-class performance**
- **+ Superior energy/power efficiency**
  - Existing & emerging applications & uses
  - Greater performance & performance per watt
  - Optimized for Intel multicore platforms
- **Single foundation for each computing segment & power envelope**
  - Optimized for mobile, desktop & server segments

Woodcrest for Servers



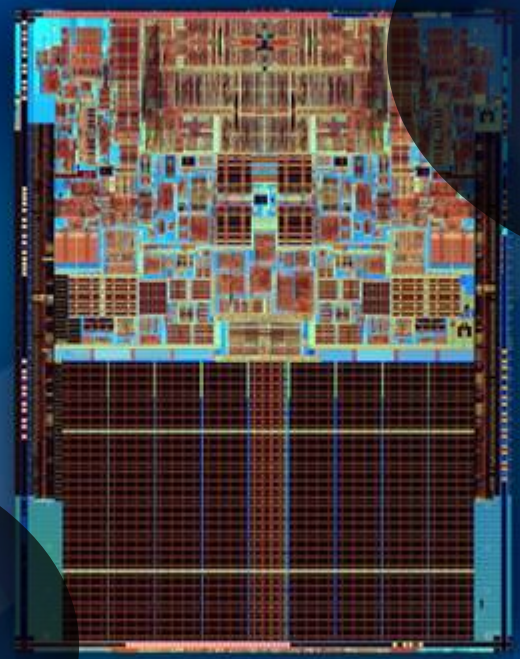
PERFORMANCE
80%

POWER
35%

...relative to
Intel® Xeon® 2.8GHz 2x2MB

Source: Intel based on estimated SPECint*_rate_base2000 & thermal design power

Conroe for Desktop



PERFORMANCE
40%

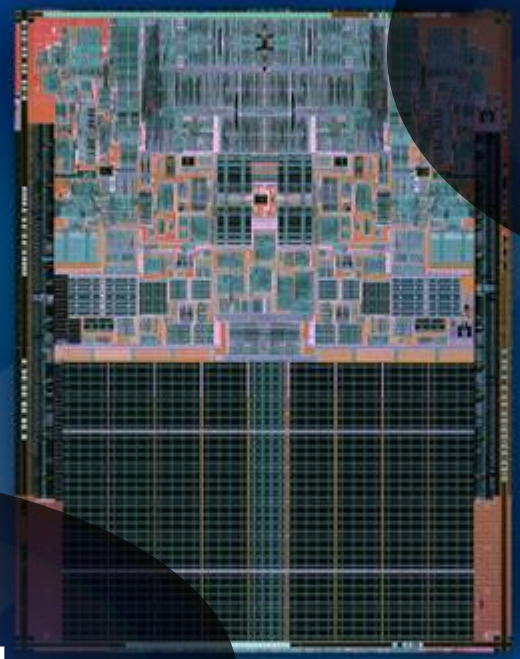
POWER
40%

…relative to Intel® Pentium® D 950

Source: Intel based on estimated SPECint*_rate_base2000 & thermal design power

Merom for Mobile

PERFORMANCE
>20%

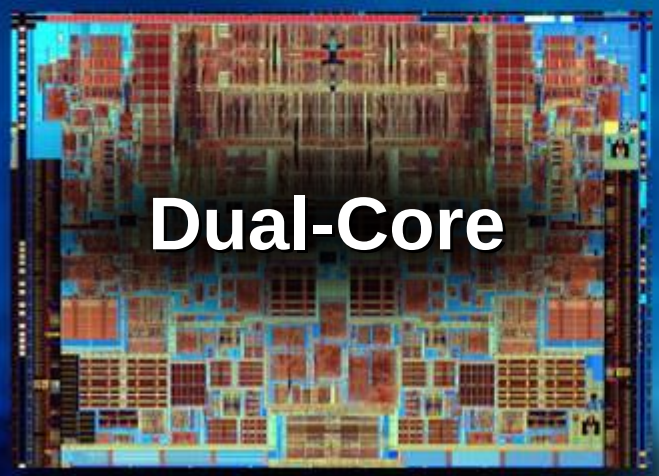


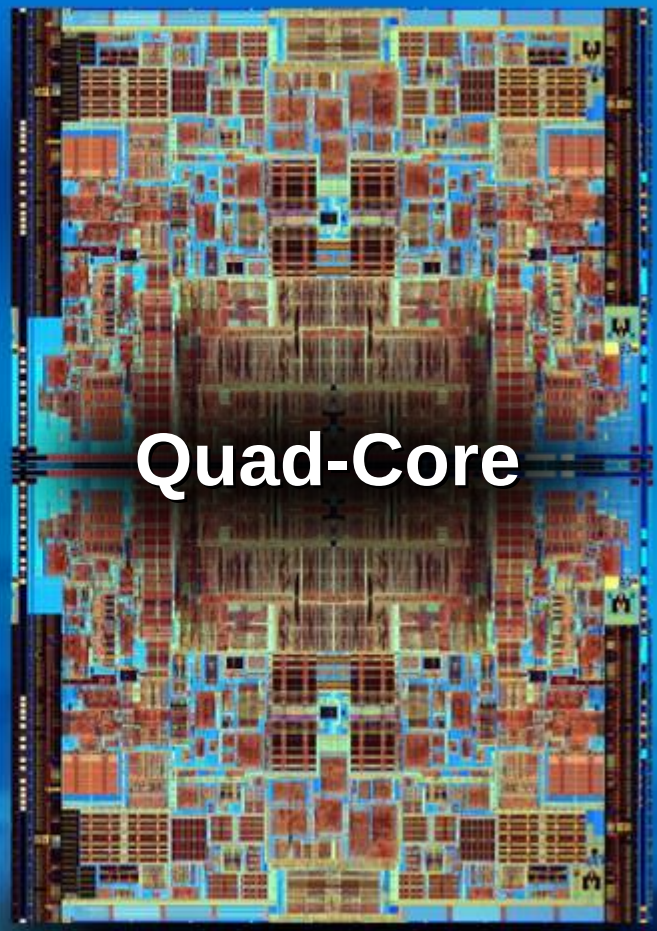
BATTERY LIFE
Constant

...relative to
Intel® Core Duo™ T2600

Source: Intel based on estimated SPECint*_rate_base2000

Multicore Trajectory

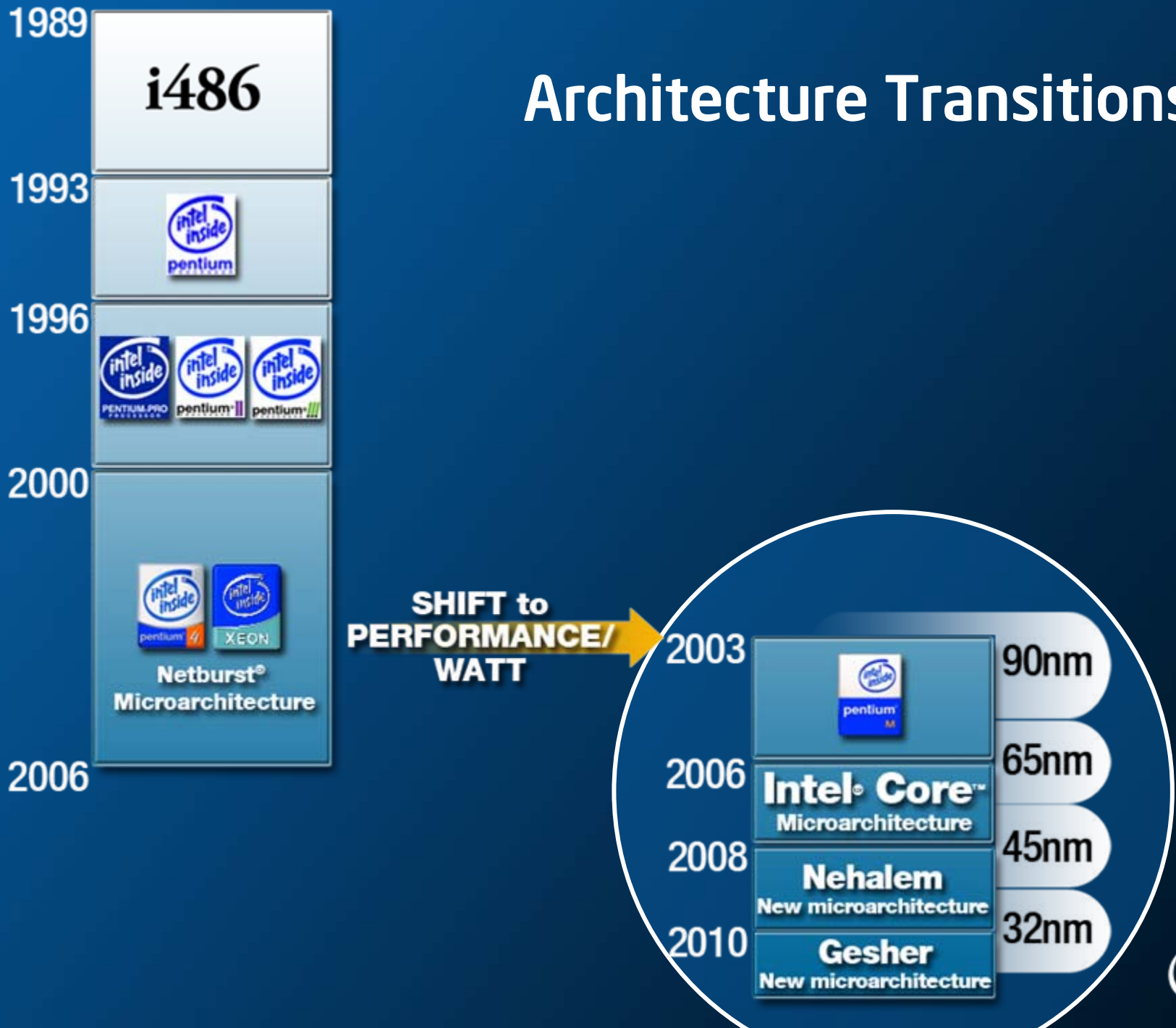




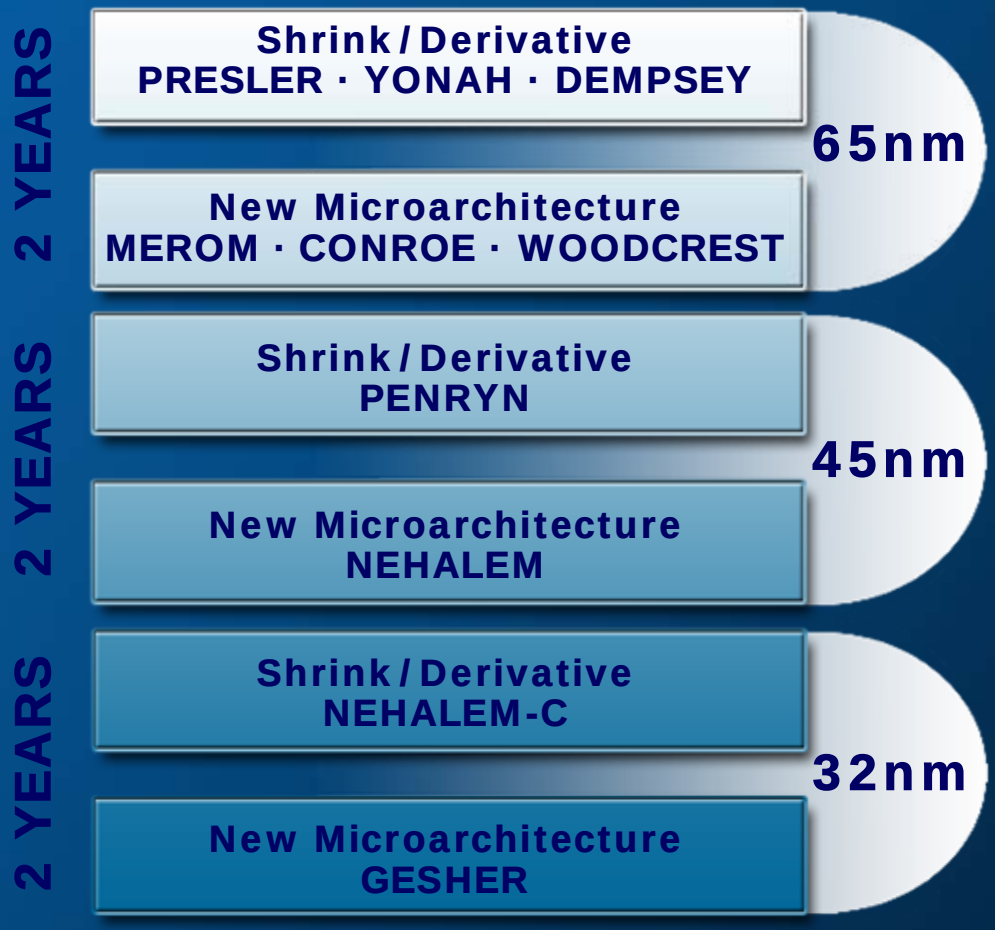
2H 2006

1H 2007

Architecture Transitions



Microprocessor Design Model



PRINCIPLES

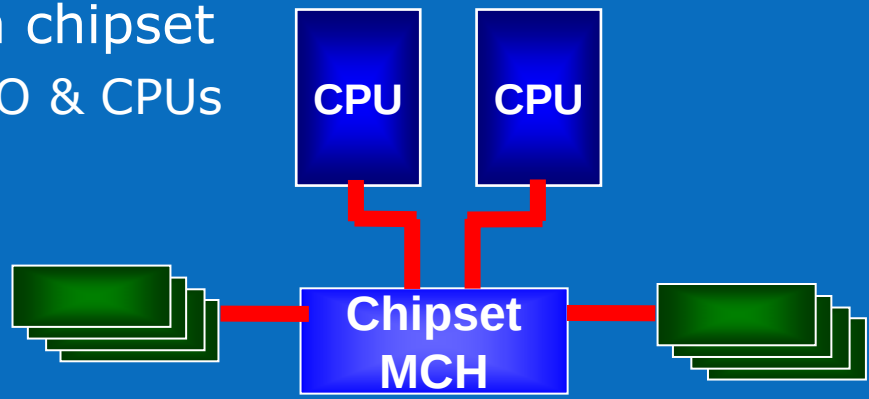
1. One micro-architecture for all high volume market segments
2. Optimized for performance/watt
3. Parallel design teams
4. No waiting on new process technology
5. Chipset cadence offset for fast ramp

OBJECTIVE: Sustained Technology Leadership

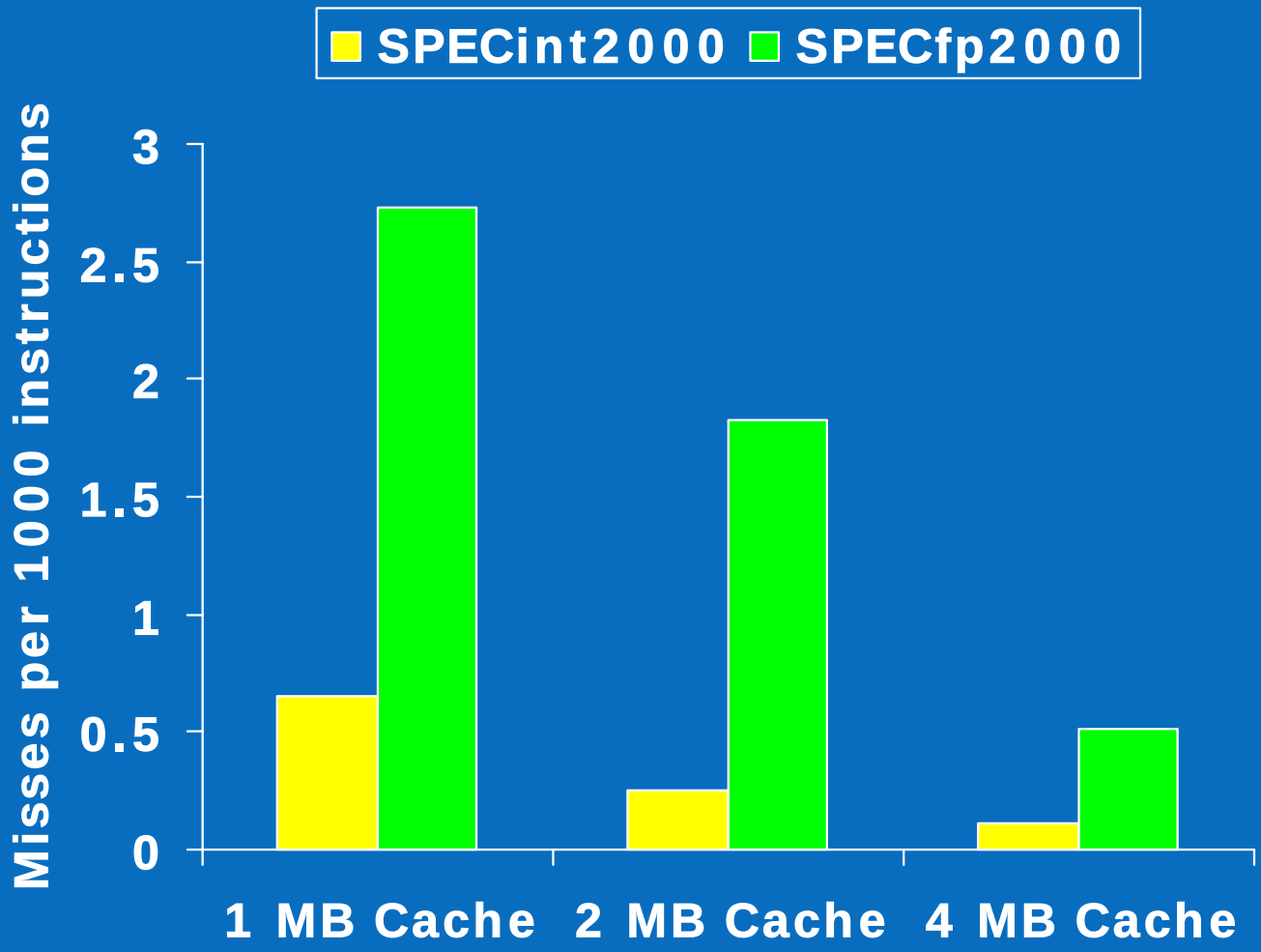
intel

Intel Server Architecture

- Memory controller on chipset using n-1 technology
  - Support high speed front side bus
  - More transistors for advanced features
- Larger cache memories in CPU
  - Boost performance by reducing off-chip memory accesses
- Flexibility to use leading-edge memory technologies
- Chipset snoop filters reduce bus traffic
- Multiple FB-DIMM channels on chipset
  - Full bandwidth available for I/O & CPUs
  - Full Memory Capacity
- RAS features in chipset



Large Cache Benefits



~5x Reduction in Memory Accesses

Today vs. Tomorrow:
A Platform Comparison

	Lindenhurst / 2004	Blackford/Greencreek	Q2 '06 vs. Today
FSB BW peak	6.4 GB/s	17 to 21 GB/s (1066MHz, 1333MHz respectively	up to 3x
Memory BW peak	6.4 GB/s	up to 21 GB/s (FBD-667)	up to >3x
Memory Capacity	16 GB (DDR2-400)	Up to 64 GB (FBD)	up to 4x

Balanced Platform Performance

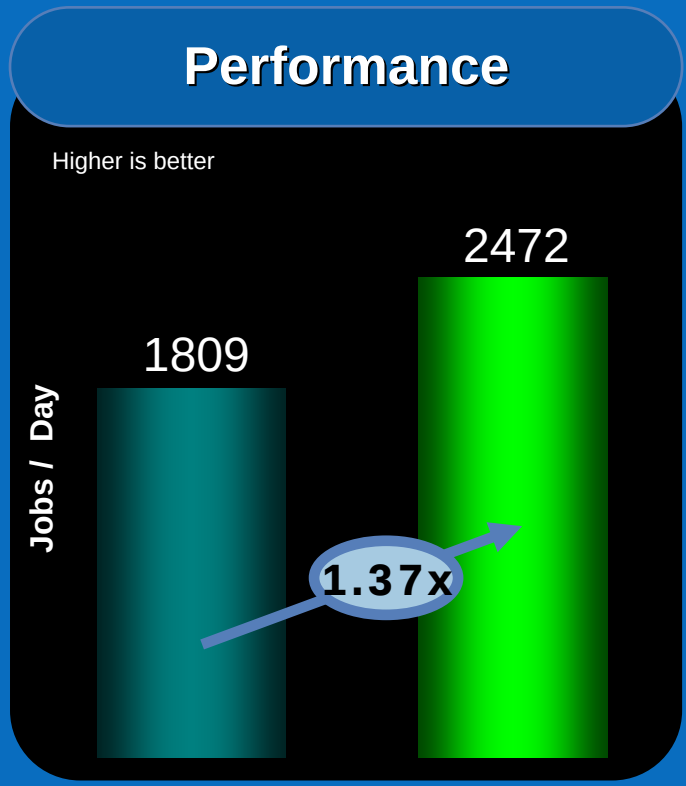
More Bandwidth & Capacity ➔ Headroom for the Future

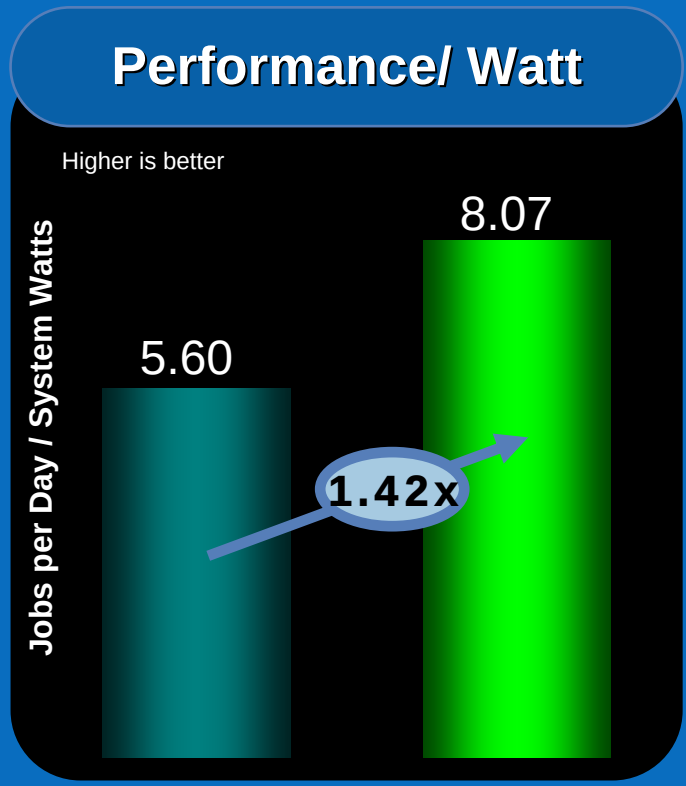
Competitive Server Performance Comparison

Compares Woodcrest & Opteron* Running SunGard ACR* financial application

Power measured is total system watts during the benchmark run

- **Woodcrest system: 306 Watts**
- **Opteron system: 323 Watts**



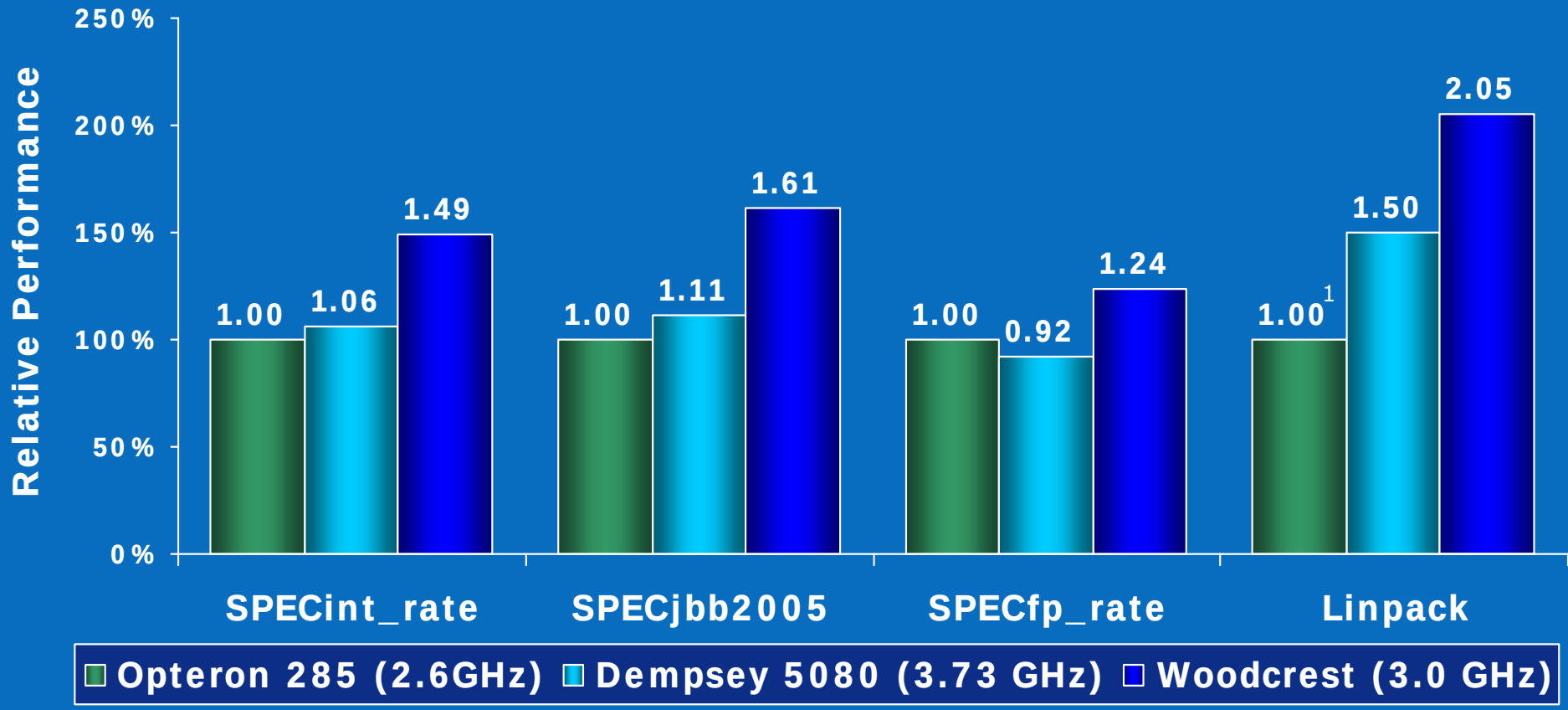


Woodcrest delivers leading Performance & Performance/ Watt

Source: Intel measurements on public stage at Spring IDF 2006. Data subject to change without notice.

64bit Dual-Core Performance

Based on Best Published or Measured Results



Expected to have Leading performance

1 – Opteron 285 published result not available, best published result from AMD.com is with Opteron 275
Opteron & Dempsey based on published results as of 3/22/06, Woodcrest based on Internal measured results, Details in Backup

Tulsa Feature Overview

Large shared 16M L3 cache

- Provides significant performance boost

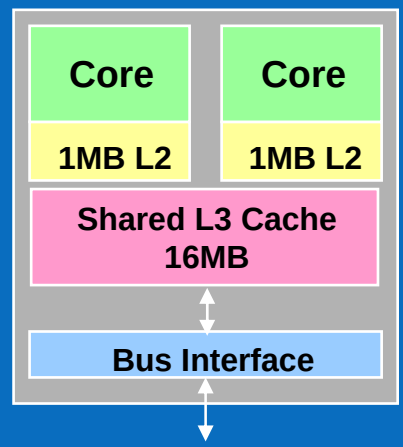
Two cores on single die targeting ≥3.4 GHz core frequency

- Four threads per processor with HT enabled on each core

Designed for existing 667/800 FSB platforms

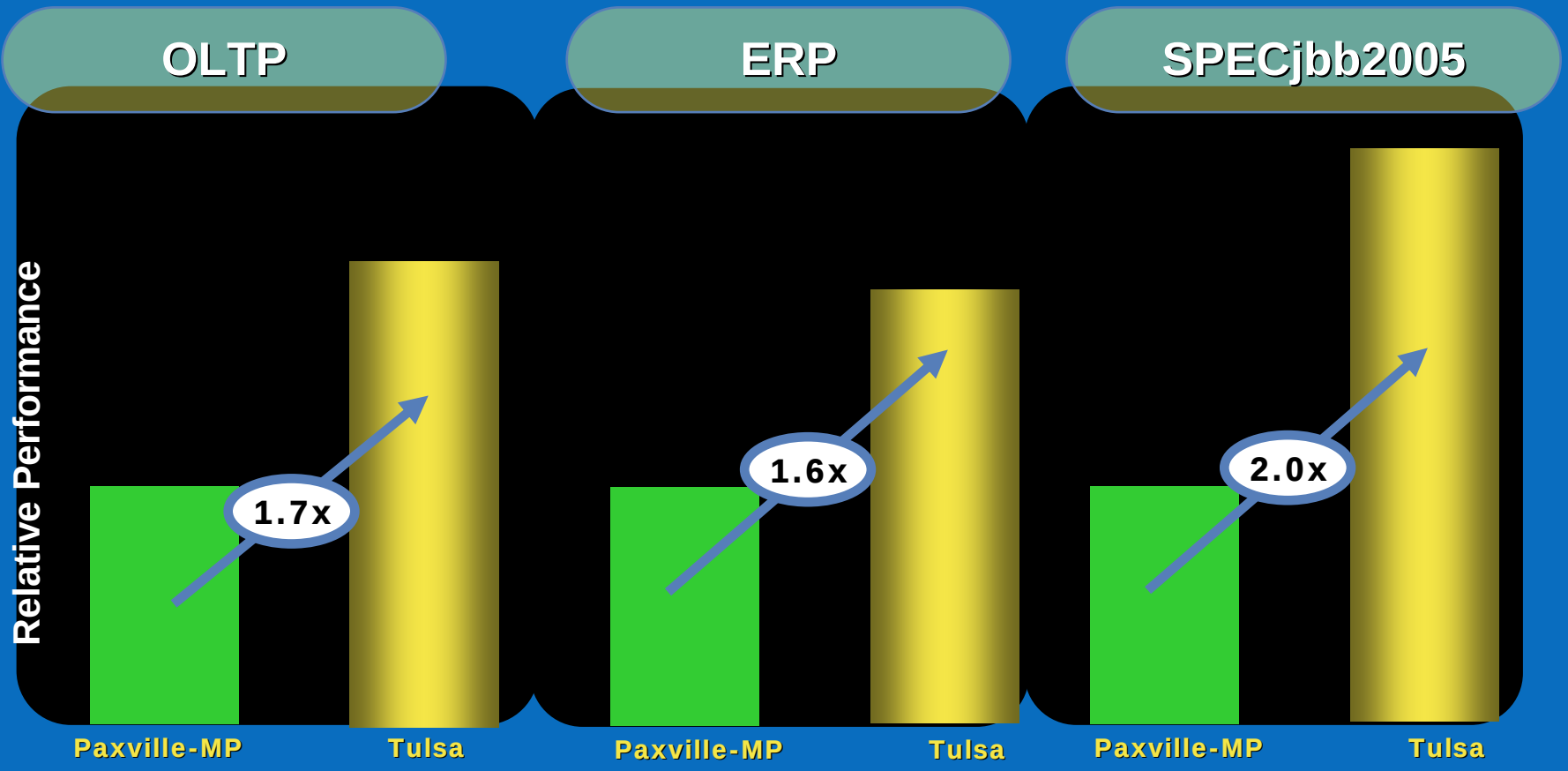
Based on 65nm process technology

- 150 & 95 Watt SKUs
- Pellston technology for improved RAS
- Virtualization technology for improved robustness & performance
- SMBus system management interface for better manageability



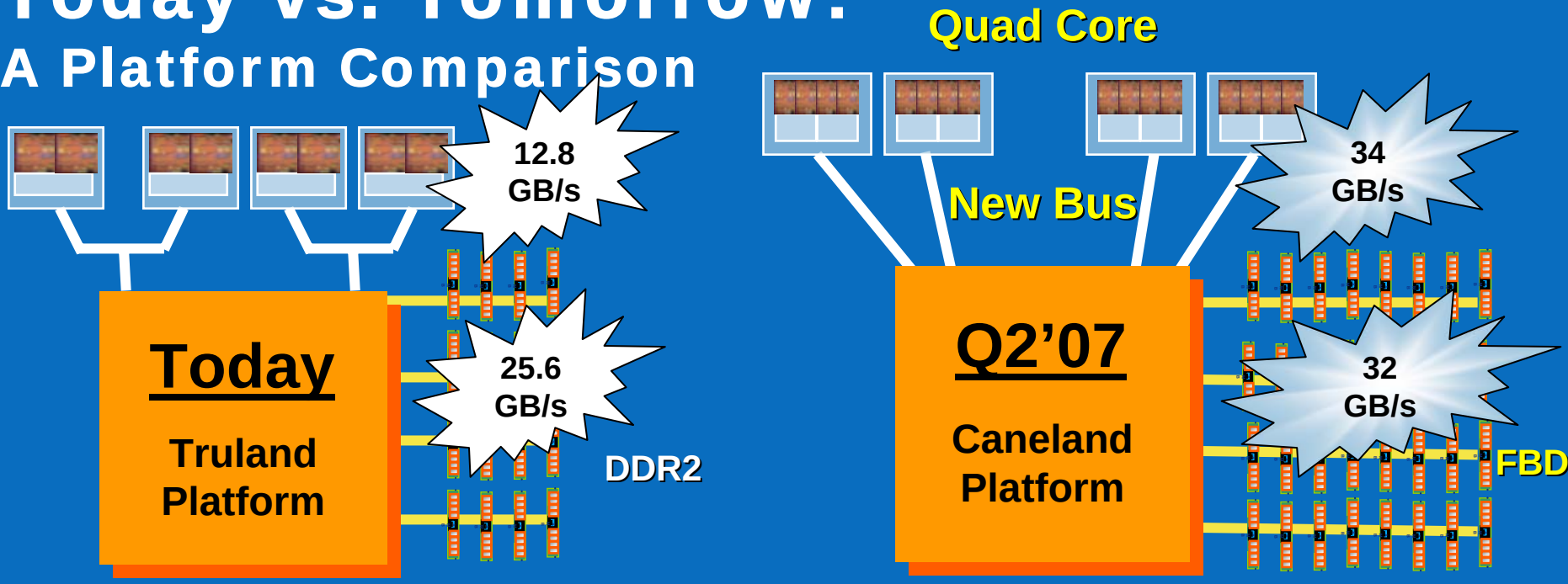
Compelling features enabling a performance boost & improved RAS & manageability

Tulsa-Truland Platform Performance



Tulsa provides a significant performance boost on many enterprise applications

Today vs. Tomorrow:
A Platform Comparison



	Trul& 2006	Canel& 2007	Q3'07 vs. Today
FSB BW peak	12.8 GB/s	34 GB/s	~3x
Aggregate Memory BW	25.6 GB/s (DDR2-400)	32 GB/s (FBD-667)	~1.25x
Memory Capacity	64 GB (DDR2-400, 4GB Dimms)	Up to 128GB (FBD 4GB Dimms)	Up to 2x

Balanced Platform Performance

More Bandwidth & Capacity ➔ Headroom for the Future

Summary

- Leading on 65nm transition & will maintain 2-year Moore's Law cycle.
- Intel leads in dual-core volume shipments.
- New Intel Core microarchitecture brings Intel performance & performance/watt leadership across desktop, notebook & 2-way server in 2H 2006.
- 4-way server performance leadership in 2H 2006.
- Intel server platform architecture delivers leadership performance without integrated memory controller.

Risk Factors

This presentation contains forward-looking statements that involve a number of risks & uncertainties. These statements do not reflect the potential impact of any mergers, acquisitions, divestitures, investments or other similar transactions that may be completed in the future. The information presented is accurate only as of today's date & will not be updated. In addition to any factors discussed in the presentation, the important factors that could cause actual results to differ materially include the following: Intel operates in intensely competitive industries that are characterized by a high percentage of costs that are fixed or difficult to reduce in the short term, & by product dem& that is highly variable & difficult to forecast. Product roadmap projections are affected by the timing & execution of the manufacturing ramp, product defects & errata (deviations from published specifications), changes in the timing of qualifying products for sale & changes in customer dem&. For a variety of reasons, we may terminate product development before completion, or delay or decide not to manufacture & sell a developed product. For example, we may decide that the product might not be sufficiently competitive in the relevant market segment, or for technological or marketing reasons, we may decide to offer a different product instead. Revenue & the gross margin percentage are affected by the timing of new Intel product introductions & the dem& for & market acceptance of Intel's products; Intel's ability to respond quickly to technological developments & to incorporate new features into its products; actions taken by Intel's competitors, including product offerings, marketing programs & pricing pressures; & the availability of sufficient inventory of Intel products & related components from other suppliers to meet dem&. Factors that could cause dem& to be different from Intel's expectations include customer acceptance of Intel & competitors' products; changes in customer order patterns, including order cancellations; changes in the level of inventory at customers; & changes in business & economic conditions. The gross margin percentage could vary from expectations based on changes in revenue levels; product mix & pricing; variations in inventory valuation, including variations related to the timing of qualifying products for sale; excess or obsolete inventory; manufacturing yields; changes in unit costs; capacity utilization; impairments of long-lived assets, including manufacturing, assembly/test & intangible assets; & the timing & execution of the manufacturing ramp & associated costs, including start-up costs. Expenses, particularly certain marketing & compensation expenses, vary depending on the level of dem& for Intel's products & the level of revenue & profits. Intel's results could be impacted by unexpected economic, social & political conditions in the countries in which Intel, its customers or its suppliers operate, including security risks, possible infrastructure disruptions, health concerns, natural disasters & fluctuations in foreign currency exchange rates. Intel's results could be affected by adverse effects associated with product defects & errata (deviations from published specifications), & by litigation or regulatory matters involving intellectual property, stockholder, consumer, antitrust & other issues, such as the litigation & regulatory matters described in Intel's SEC reports. Intel's results could be affected by the amount, type, & valuation of share-based awards granted as well as the amount of awards cancelled due to employee turnover & the timing of award exercises by employees. Please refer to Intel's most recent Earnings Release & most recent Form 10-K or 10-Q filing for more information on the risk factors that could cause actual results to differ.

Rev. 4/19/06

Legal Disclaimer

LEGAL INFORMATION:

THIS DOCUMENT AND RELATED MATERIALS AND INFORMATION ARE PROVIDED "AS IS" WITH NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE. INTEL ASSUMES NO RESPONSIBILITY FOR ANY ERRORS CONTAINED IN THIS DOCUMENT AND HAS NO LIABILITIES OR OBLIGATIONS FOR ANY DAMAGES ARISING FROM OR IN CONNECTION WITH THE USE OF THIS DOCUMENT.

Performance & functionality will vary depending on (i) the specific hardware & software you use & (ii) the feature enabling/system configuration by your system vendor. See www.intel.com/ for information on Intel Technology or consult your system vendor for more information.

All dates provided are subject to change without notice.

Intel, Pentium, Xeon, Itanium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States & other countries.

*Other names & br&s may be claimed as the property of others.